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New species, notes and new records of *Trichogramma* (Hymenoptera: Trichogrammatidae) in Brazil

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Abstract

Two new species of *Trichogramma* are described: *Trichogramma piracicabense* sp. nov. and *T. valmiri* sp. nov. Additionally, *T. manicobai* from eggs of the cassava hornworm *Erinnyis ello* is redescribed, and new records on the distribution and host associations of species of *Trichogramma* from Brazil are presented.

Key words: taxonomy, egg parasitoids, insect hosts

Introduction

Trichogramma Westwood is the largest genus in the family Trichogrammatidae, with ca. 210 species worldwide (Pinto 2006). Although the genus has attracted considerable attention for well over a century because of its significance for biological control, its taxonomy remains inadequately resolved (Pinto 1999, 2006). Taxonomic studies of the group have historically been based on occasional collections and on surveys in agricultural areas. However, extensive surveys in undisturbed habitats should be conducted to increase the knowledge of the diversity of *Trichogramma* (Querino & Zucchi 2003).

The genus contains three subgenera, *Trichogramma* s. restr., *Trichogrammanza* Carver, and *Vanlisus* Pinto. The nominate subgenus is cosmopolitan in distribution and includes ca. 200 recognized species. *Trichogrammanza* comprises three species, restricted to Australia and New Zealand. *Vanlisus* contains four species divided into two species groups (*lachesis*, three species in the New World; and *primaevum*, one species, *T. primaevum* from Australia) (Pinto, 1999).

In the New World, 60 species are recorded in North America, 22 in Central America and 41 in South America (Zucchi et al 2010). Twenty-six of the native species in South America occur in Brazil. In the subgenus *Vanlisus*, only *T. atropos* Pinto has been recorded in South America, from Brazil and Venezuela (Pinto 1992, 1999).

This contribution describes two new species of *Trichogramma* from Brazilian forest habitats. Additionally, *T. manicobai* is redescribed, and new records on the distribution and host associations of several species of *Trichogramma*, including a member of the subgenus *Vanlisus*, are presented.

Material and methods

The descriptions, measurements and figures were made with the aid of a Nikon Eclipse E200 microscope. Photographs were taken using Moticam 2000 with Motic Images Plus 2.0. The terminology for morphological structures and ratios is based on Pinto (1999). The following abbreviations for morphological structures are used in

the descriptions: aedeagus length (AL), apical distance (AD), apical width (AW), basal distance (BD), basiconic peg sensilla (BPS), dorsal aperture (DA), dorsal lamina (DLA), dorsal ridge (DR), forewing length (FWL), forewing width (FWW), genital capsule (GC), Genital capsule length (GL), genital capsule width (GW), Hind tibial length (HTL), intervolssellar process (IVP), length of flagellum scape (LFS), length of the flagellum (FL), length of the longest flagelliform seta (FSL), width of the flagellum (FW), parameres (PM), placoid sensilla (PLS), the longest flagelliform seta (FSL), ventral processes (VP), ventral ridge (VR), volsellae (VS).

Quantitative data include the mean (in μm) followed by the standard deviation; the number of specimens examined follows each species description.

The type specimens are deposited in the collections of the Escola Superior de Agricultura Luiz de Queiroz (ESALQ), Piracicaba, São Paulo, Brazil, and the Department of Entomology, University of California, Riverside (UCR), Riverside, California, USA. All descriptions are based on males. The types of *Trichogramma piracicabense* Querino & Zucchi sp. nov. were remounted in Canada balsam.

Results

Taxonomy

Trichogramma piracicabense Querino & Zucchi sp. nov.

Figs 1–4

Diagnosis. *Trichogramma piracicabense* is easily distinguished by the funnel-shaped dorsal lamina with narrower posterior extension. Genital capsule with sides typically gradually convergent posteriorly, not constricted at level of IVP. Intervolssellar process short. Ventral process positioned anterior to base of intervolssellar process and ventral process relatively distant from each other. Apical distance relatively long.

Description. Male. Based on field-collected specimens from the host. Quantitative data taken from three males (HTL = $110.8 \pm 2.2 \mu\text{m}$). Color of mounted specimens brown.

Antenna. Flagellum relatively short (121.8 ± 2.4), twice as long as scape (60.6 ± 4.1), FL/FW = 5.64 ± 0.15 , FL/HTL = 1.10 ± 0.0 ; flagelliform setae long (75.4 ± 3.3), evenly tapering to apex, ca $3.5 \times$ FW, FSL/FW = 3.48 ± 0.09 ; basiconic sensilla ovaliform, formula 2-2-2-0-1-1; three placoid sensilla, terminal PLS = 29.0 ± 1.9 with apical sensillum extending beyond apex of flagellum 6.0 ± 1.2 .

Wings. Forewing slightly infuscate; FWW/FWL = 0.51 ± 0.01 ; fringe setae = 32.3 ± 1.3 , $0.22 \times$ FWW, ca. $0.29 \times$ HTL; 7–10 setae between 4th and 5th setal tracks. Hind wing with anterior track absent, posterior track with 3 to 4 setae, not reaching midpoint of middle track.

Scutum/Scutellum. Smooth, microsculpturing indistinct. Scutellum with anterior pair of setae 4.6 length of posterior pair.

Genital capsule. 0.39 ± 0.0 as wide as long, usually widest slightly anterior to middle; sides typically gradually convergent posteriorly, not constricted at level of IVP; PM slightly convergent; AD elongate, AD/GL = 0.27 ± 0.01 ; AW/GW = 0.65 ± 0.01 ; DA elongate, DA/GL = 0.27 ± 0.01 ; DLA originating near middle of capsule, funnel-shaped, divided into two parts, a wider basal section and a narrower long (31.7 ± 0.5) posterior extension with rounded apex exceeding apex of VS. DLA notched laterally at base, shoulders present and not approaching GC, sides gradually tapering apically, forming sublinguiform posterior extension whose width at level of IVP is less than that of aedeagus; DLA 1.26 ± 0.01 as long as wide, DLA/GL = 0.46 ± 0.01 ; VS relatively straight, symmetrical; IVP short, pointed apically, occupying $0.2 \times$ AD; VR short (25.2 ± 0.01), occupying $0.33 \times$ BD (anterior limits difficult to discern in mounted specimen); VP positioned anterior to base of IVP and far from VR and each other; AL ca. 0.57 length of apodemes, AL/HTL = 0.39 ± 0.02 ; apodemes $1.75 \times$ AL.

Type material. Holotype: male, BRAZIL. SÃO PAULO: Piracicaba ($22^{\circ}42'30''\text{S}$, $047^{\circ}38'00''\text{W}$, 546 m a.s.l.), x/2002, ex eggs *Heraclides astyalus* on *Citrus* sp., J. A. Cerignoni collr. (ESALQ). Paratypes: 2 males, same data as holotype (ESALQ).

Distribution. Known only from the type locality.

Host. *Heraclides astyalus* (Papilionidae) on *Citrus* sp.

Etymology. The species epithet is an adjective derived from the type locality.

Remarks. In the key of Querino & Zucchi (2005), *Trichogramma piracicabense* runs to *T. pratissolii* Querino & Zucchi or *T. zucchii* Querino, from which it differs in having shorter flagelliform setae, a funnel-shaped dorsal lamina, and a shorter ventral ridge. This new species also somewhat resembles *T. bruni*, but differs in having the posterior extension of the dorsal lamina narrower and the ventral processes widely separated and near the base of the intervolsellar process, and shorter flagelliform setae.



FIGURES 1–4. *Trichogramma piracicabense* Querino & Zucchi sp. nov. Male. 1: Antenna; 2: Wings; 3: Genital capsule, ventral view; 4: Genital capsule, dorsal view.

Trichogramma valmiri Querino & Zucchi sp. nov.

Figs 5–9

Diagnosis. *Trichogramma valmiri* can be recognized by the male flagellum relatively short with unsocketed setae in the four regions, and the flagelliform setae very short. These features, together with the short IVP and the ventral process positioned at the base of the IVP, separate this species from other members of *Trichogramma*.

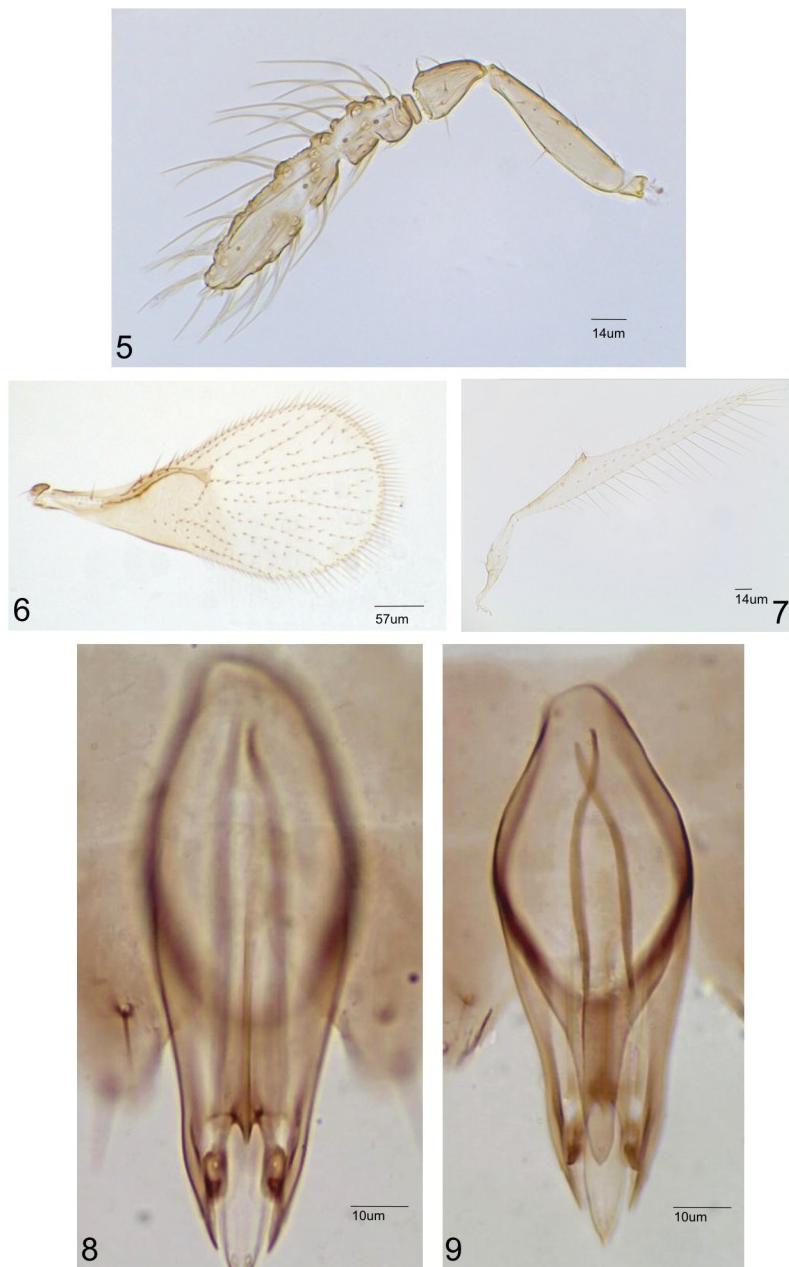
Description. Male. Based on field-collected specimens from the host. Quantitative data taken from 5 males (HTL = $108.6 \pm 2.5 \mu\text{m}$). Color of mounted specimens brown.

Antenna. Flagellum short (95.3 ± 3.5), 1.5x length of scape (60.3 ± 1.8), FL/FW = 4.90 ± 0.4 , FL/HTL = 0.9 ± 0.0 ; flagelliform setae short (38.3 ± 2.2), evenly tapering to apex, ca. 1.96x FW, FSL/FW = 1.95 ± 0.1 ; unsocketed

setae along ventral surface of flagellum; basiconic sensilla prominent, subglobose, formula 2-2-2-0-1-1; three placoid sensilla, terminal PLS = 32.0 ± 1.9 with apical sensillum extending beyond apex of flagellum 4.6 ± 0.4 .

Wings. Forewing slightly infuscate behind venation; FWW/FWL = 0.54 ± 0.01 ; fringe setae = 25.8 ± 0.8 , 0.12 FWW, ca. 0.24 HTL; 9-11 setae between 4th and 5th setal tracks. Hind wing with anterior track usually absent, posterior track with 3 to 5 setae, not reaching midpoint of middle track.

Scutum/Scutellum. Smooth, microsculpturing indistinct. Scutellum with anterior pair of setae $4.4 \times$ length of posterior pair.



FIGURES 5–9. *Trichogramma valmiri* sp. nov. Male. 5: Antenna; 6: Forewing; 7: Hindwing; 8: Genital capsule, ventral view; 9: Genital capsule, dorsal view.

Genital capsule. 0.38 ± 0.02 as wide as long, usually widest slightly anterior to middle; sides typically gradually convergent posteriorly, slightly constricted at level of IVP; PM slightly convergent; AD elongate, AD/GL = 0.23 ± 0.01 ; AW/GW = 0.62 ± 0.01 ; DA elongate, DA/GL = 0.22 ± 0.01 ; DLA originating slightly anterior to middle of GC, slightly to moderately notched with little-developed shoulders, width at shoulders less than width anterior to notch, sides tapering to form sublinguiform posterior extension whose width at level of IVP is slightly

less than aedeagus width, extending to near apex of VS; posterior extension of DLA long, 27.8 ± 1.5 ; DLA 1.30 ± 0.05 as long as wide, DLA/GL = 0.46 ± 0.02 ; VS relatively straight, symmetrical; IVP short, pointed apically, occupying 0.15 AD; VR only moderately elongate (36.3 ± 1.0), occupying 0.48 BD, distinct, easily observed; VP positioned at base of IVP and near VR; AL ca. 0.47 length of apodemes, AL/HTL = 0.41 ± 0.02 ; apodemes $1.09x$ AL.

Type material. Holotype: male, BRAZIL. SÃO PAULO: Jundiaí ($23^{\circ}11'12''S$, $046^{\circ}53'03''W$), 18.v.2011, ex eggs *Urbanus esta* on *Desmodium uncinatum*, M. S. Franco collr. (ESALQ). Paratypes: 3 males, same data as holotype (ESALQ).

Material examined. BRAZIL. SÃO PAULO: Anhembi, 1 male, 01-ix-1999, unknown host on *Eucalyptus* sp., R. B. Querino collr. (ESALQ, specimen damaged in remounting in Canada balsam); Piracicaba, Tupi forest reserve, 1 male, 05-vi-2000, suction trap, R. B. Querino collr. (ESALQ, remounted in Canada balsam).

Distribution. Brazil: São Paulo (Anhembi, Jundiaí, Piracicaba).

Hosts. *Urbanus esta* Evans, 1952 (Lepidoptera, Hesperiidae) on *Desmodium uncinatum*; unknown host on *Eucalyptus* sp.

Etymology. The species epithet honors Valmir Antonio Costa for his studies on hymenopteran parasitoids.

Remarks. In the key of Querino & Zucchi (2005), *Trichogramma valmiri* Querino & Zucchi sp. nov. runs to *T. bruni*, *T. rojasi* Nagaraja & Nagakartti or *T. lasallei* Pinto, from which it differs mostly in having a relatively short flagellum with unsocketed setae. This characteristic is unique among the South American species. Additionally, in *T. valmiri*, the ventral processes are located at the base of the IVP and near the VR, while in *T. lasallei* the ventral processes are situated anteriorly (distant from the base of the intervalsellar process) and the short ventral ridge has an indistinct anterior limit (difficult to observe with the optical microscope). In *T. bruni*, the ventral processes are close to the base of the intervalsellar process and the ventral ridge is long; in *T. rojasi* the ventral processes are located very near the base of the intervalsellar process, the ventral ridge is short and distinct, and the posterior track of setae reaches the apex of the hind wings.

Trichogramma valmiri Querino & Zucchi is the *Trichogramma* species reported by (Franco 2013) as a parasitoid of *Urbanus esta* (Lepidoptera: Hesperiidae) eggs on *Desmodium uncinatum*. The mean percentage of parasitism was 26.6% during the two years of data collection.

Trichogramma manicobai Brun, Moraes & Soares, 1984

Figs 10–13

Trichogramma maniçobai Brun, Moraes & Soares, 1984: 807.

Trichogramma manicobai: Zucchi, 1985: 47 (emendation); Zucchi & Monteiro, 1997: 54 (catalog); Querino & Zucchi, 2005: 40 (key); Zucchi et al., 2010: 233 (catalog); Querino & Zucchi, 2011: 57.

Material examined. BRAZIL. MINAS GERAIS: Lavras, 10.v.1984, 1 male, ex eggs of *Erinnyis ello* on *Hevea brasiliensis* (D. Pratissoli collr.), Janaúba, 9.iii.2010, 1 male, ex eggs of *Erinnyis ello* on *Manihot esculenta* Crantz (J. M. Vieira collr.); SÃO PAULO: Campinas, 01.vi.1985, 1 male, ex eggs of *Erinnyis ello* on *Manihot esculenta* (W. Reis collr.); PARANÁ: Marechal Cândido Rondon, 12.XII.2001, 5 male, ex eggs of *Erinnyis ello* on *Manihot esculenta* (V. Pietrowski collr.) (ESALQ).

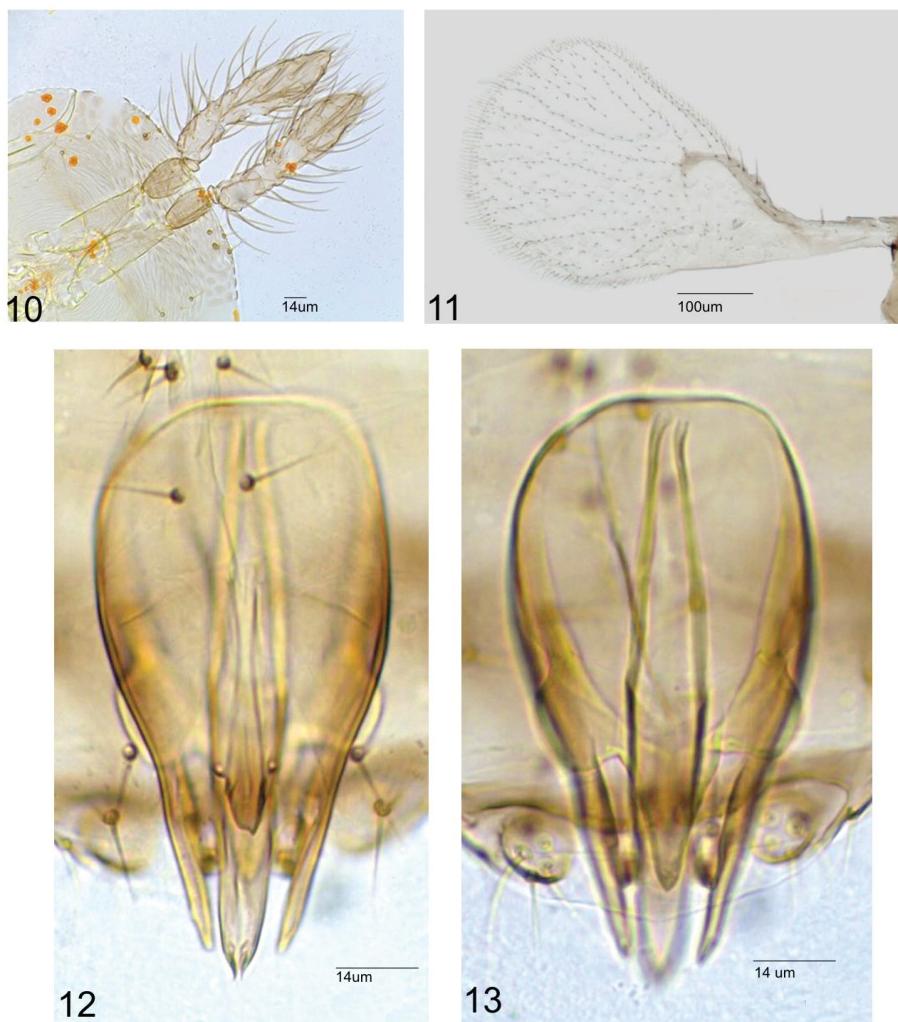
Diagnosis. *Trichogramma manicobai* is the most easily recognized South American species. It is identified by the wide genital capsule, especially the dorsal lamina with lateral projections, and the short wide intervalsellar process with a truncated or bifid apex.

Description. Male. Based on field-collected specimens from host. Quantitative data taken from 8 males (HTL = $175.0 \pm 4.3 \mu\text{m}$). Color of living specimens yellowish brown.

Antenna. Flagellum relatively short (141.5 ± 6.0), FL/FW = 3.41 ± 0.18 ; FL/HTL = 0.81 ± 0.03 ; flagelliform setae short (57.1 ± 2.2), with abruptly tapered apex; FSL/FW = 1.38 ± 0.09 ; placoid sensilla, terminal PLS = 48.3 ± 1.7 .

Wings. Forewing not infuscate behind venation; FWW/FWL = 0.54 ± 0.01 ; fringe setae = 30.7 ± 0.9 ; ca. $0.18 \times$ HTL, 0.11 FWW; 10–26 setae between 4th and 5th setal tracks. Anterior track of hind wing with 2 setae, posterior track with 7 to 8 setae, reaching midpoint of middle track.

Scutum/Scutellum. Scutellum with anterior pair of setae 0.3 length of posterior pair.



FIGURES 10–13. *Trichogramma manicobai*. Male. 10: Antenna. 11: Forewing. 12: Genital capsule, ventral view. 13: Genital capsule, dorsal view.

Genital capsule. Genital capsule 0.57 ± 0.02 as wide as long; AD elongate with $AD/GL = (0.30 \pm 0.01)$; AW/GW = (0.61 ± 0.03) ; DLA with lateral projections extending beyond margin of genital capsule, DLA (0.65 ± 0.02) as long as wide, $DLA/GL = 0.33 \pm 0.01$; AD/DLA = 1.97 ± 0.07 ; posterior extension of DLA long, 34.2 ± 0.9 , with pointed apex, exceeding apex of VS. VR long (50.3 ± 1.8), occupying ca. 0.56 BD; BD/GL = 0.30 ± 0.01 ; IVP short, pointed apically, usually with truncated apex and sometimes bifid. VP positioned near base of IVP; AL/HTL = 0.38 ± 0.02 ; apodemes 1.09 AL.

Distribution. Brazil: Mato Grosso do Sul, Minas Gerais, Paraná, Piauí and São Paulo.

Remarks. Specimens of *T. manicobai* show intraspecific variations in the apex of the intervolsellar process (truncated or bifid), and the apex of the dorsal lamina (rounded, or pointed and bifid). The type material shows variation in the length of the flagelliform setae relative to the width of the flagellum (Zucchi 1985). In the specimens from Lavras, the proportion of the adeagus to the apodemes is slightly smaller than of specimens in the type series.

New records

Based on specimens deposited in the ESALQ collection, new records of distribution and host associations for six species of *Trichogramma* were established. *Trichogramma (Vanlisus) cloicho* is the second species of the subgenus recorded in Brazil (Table 1). Previously, the only member of this subgenus recorded in Brazil was *T. atropo*, at Nova Teutônia, Santa Catarina (Pinto 1999).

Trichogramma (*Vanlisus*) *cloicho* is the *Trichogramma* species mentioned by Kaminski *et al.* (2012) as one of the natural enemies of *Parrhasius polibetes* (Stoll, 1781) (Lepidoptera: Lycaenidae).

TABLE 1. New records for the state of São Paulo, Brazil, and host associations for some species of *Trichogramma*.

<i>Trichogramma</i> species	Lepidopteran host	Plants associated	Collecting method	Municipality	Site	Year
<i>T. aff. bruni</i>	<i>Melanolophia</i> sp.	Forest reserve	Eggs	Sorocaba	Horto de Itavuvu	1992
<i>T. bruni</i>	<i>Heraclides astyalus</i>	<i>Citrus</i> sp.	Eggs	Piracicaba	ESALQ	2002
<i>T. esalqueanum</i>	Unknown	Forest reserve	Suction trap	Piracicaba	Horto de Tupi	2000
<i>T. cloicho</i>	<i>Parrhasius polibetes</i>	<i>Schefflera vinosa</i> and <i>Pyrostegia venusta</i>	Eggs	Campinas	Japi forest reserve	2010
<i>T. pretiosum</i>	<i>Heraclides astyalus</i>	<i>Citrus</i> sp.	Eggs	Piracicaba	ESALQ	2002
<i>T. zucchii</i>	<i>Melanolophia</i> sp.	Forest reserve	Eggs	Sorocaba	Horto de Itavuvu	1992

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